STRUCTURAL DESIGN - I

10. Design of Staircase

Kiran S R
Lecturer
Department of Civil Engineering
Central Polytechnic College Thiruvananthapuram

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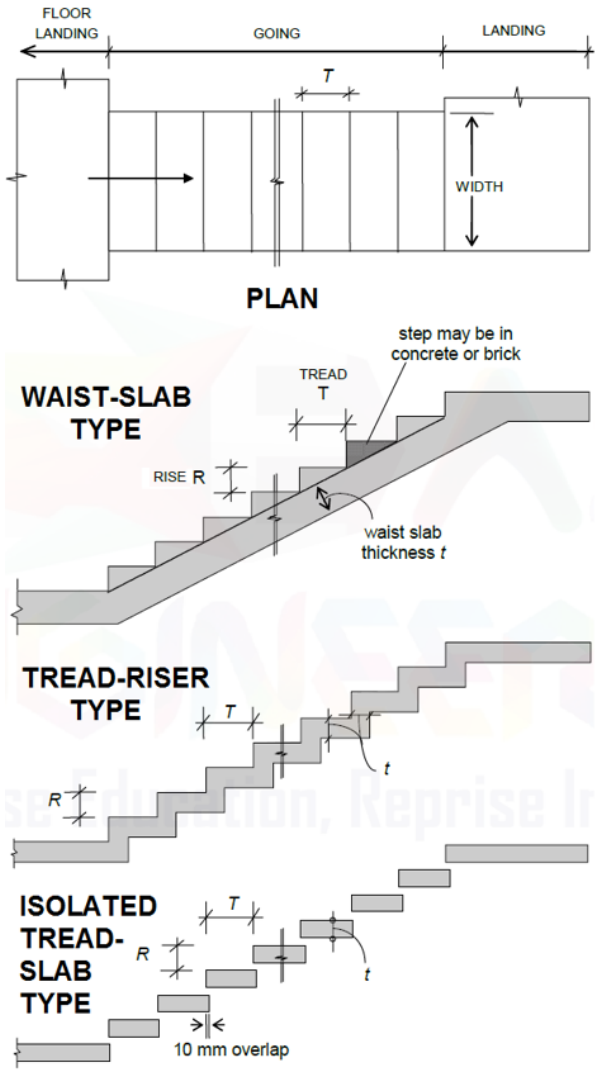
Contents

1. Definition of Terminologies
   - Parts of Staircase
   - Types of Stairs
2. Codal Design Parameters
   - Determining Geometric Parameters
   - Determining Structural Parameters
     - Landing slab spanning in the same direction of stairs
     - Landing slab spanning transverse to the direction of stairs
     - Calculation of Loads

Definition of Terminologies

Staircase is the means of access between the various levels or floors in a building.
(Vertical Transportation)



Parts of Staircase

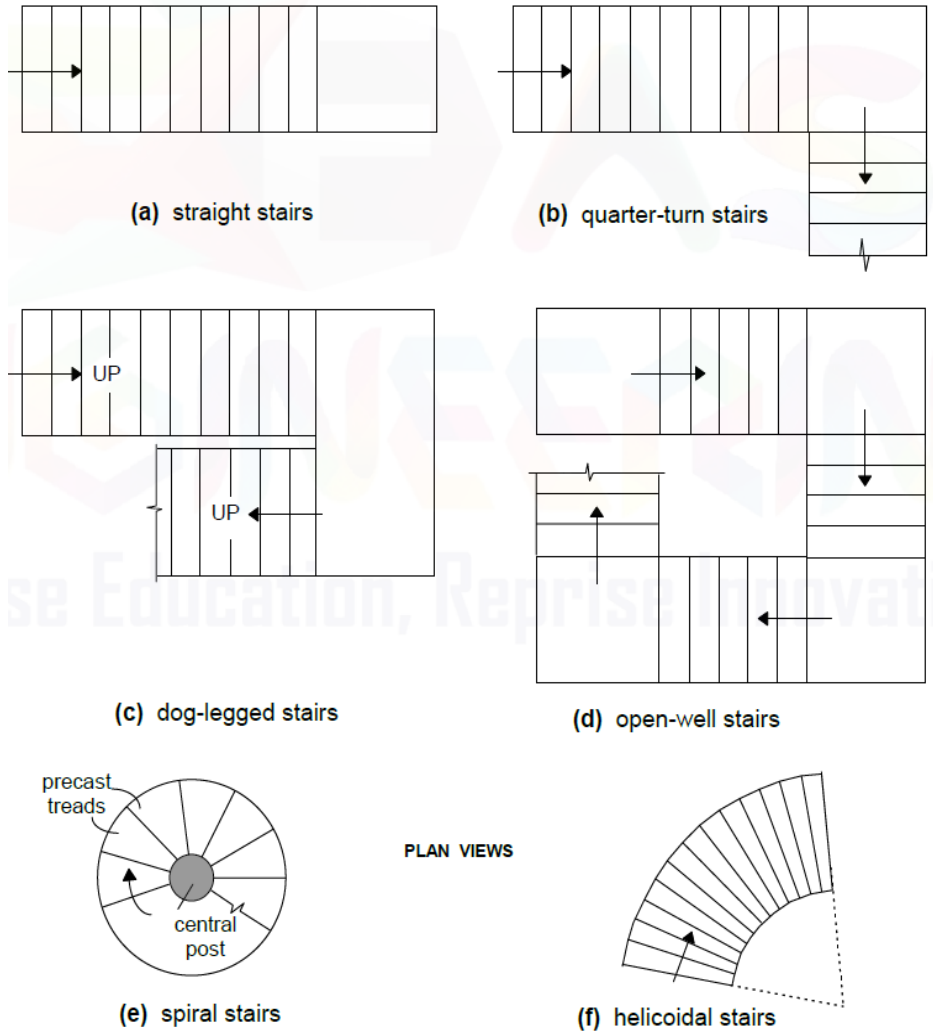
- It consists of:
  - a flight of steps
    The horizontal projection (plan) of an inclined flight of steps is termed going.
  - intermediate landings (horizontal slab platforms) provided between the floor levels.
- The horizontal top portion of a step (where the foot rests) is termed **Tread** and the vertical projection of the step (i.e., the vertical surface between two neighbouring treads) is called **Riser**.

Definition of Terminologies

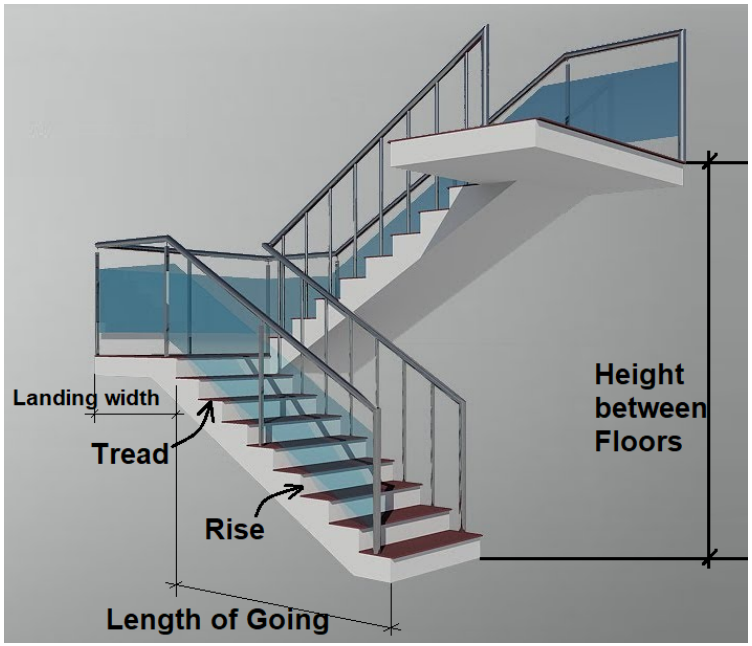
Types of Stairs

Based on Geometric Configuration

- Straight flight stairs
- Quarter-turn stairs
- Dog-legged stairs
- Open-well stairs
- Spiral stairs
- Helicoidal stair



Codal Design Parameters



Determining Geometric Parameters

- Generally, we take:
  Tread= ˜300 mm ; Rise= ˜150 mm
- Number of risers = $\frac{Height\ \ between\ \ floors}{Rise}$
- Number of risers in a flight should not exceed 12 numbers.
- Number of Treads = Number of Risers − 1
- Width of the stair is generally around 1.10 − 1.60m, and in any case, should normally not be less than 0.85m.
- Length of going = Tread x Number of treads
- Length of landing= ˜Width of stair

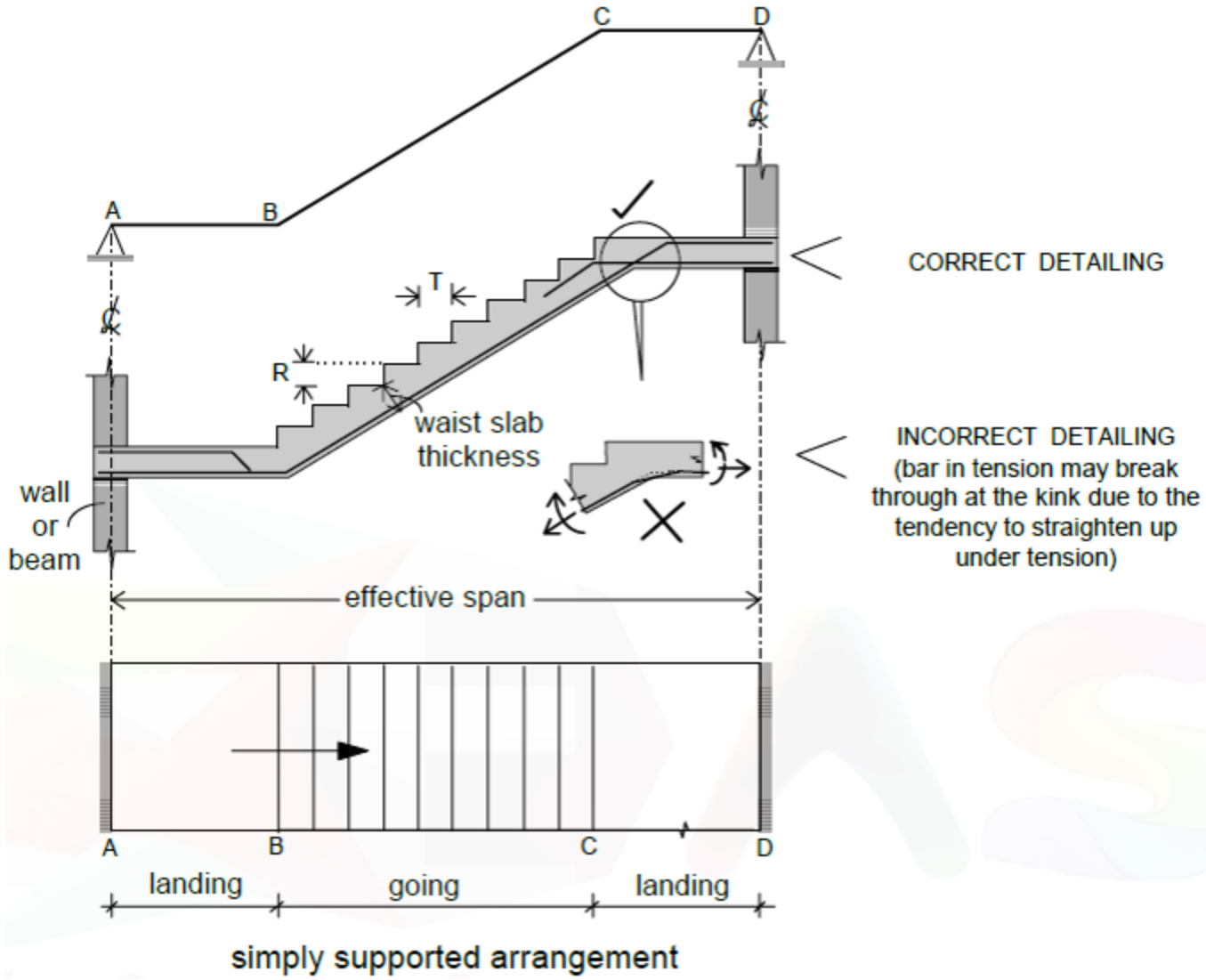
Codal Design Parameters

Determining Structural Parameters

- Staircase is designed as a simply supported one-way slab of one metre width.
- There arise 2 cases of staircase based on the way Landing slab spans
  - Landing slab spanning in the same direction of staircase
  - Landing slab spanning perpendicular to the direction of staircase

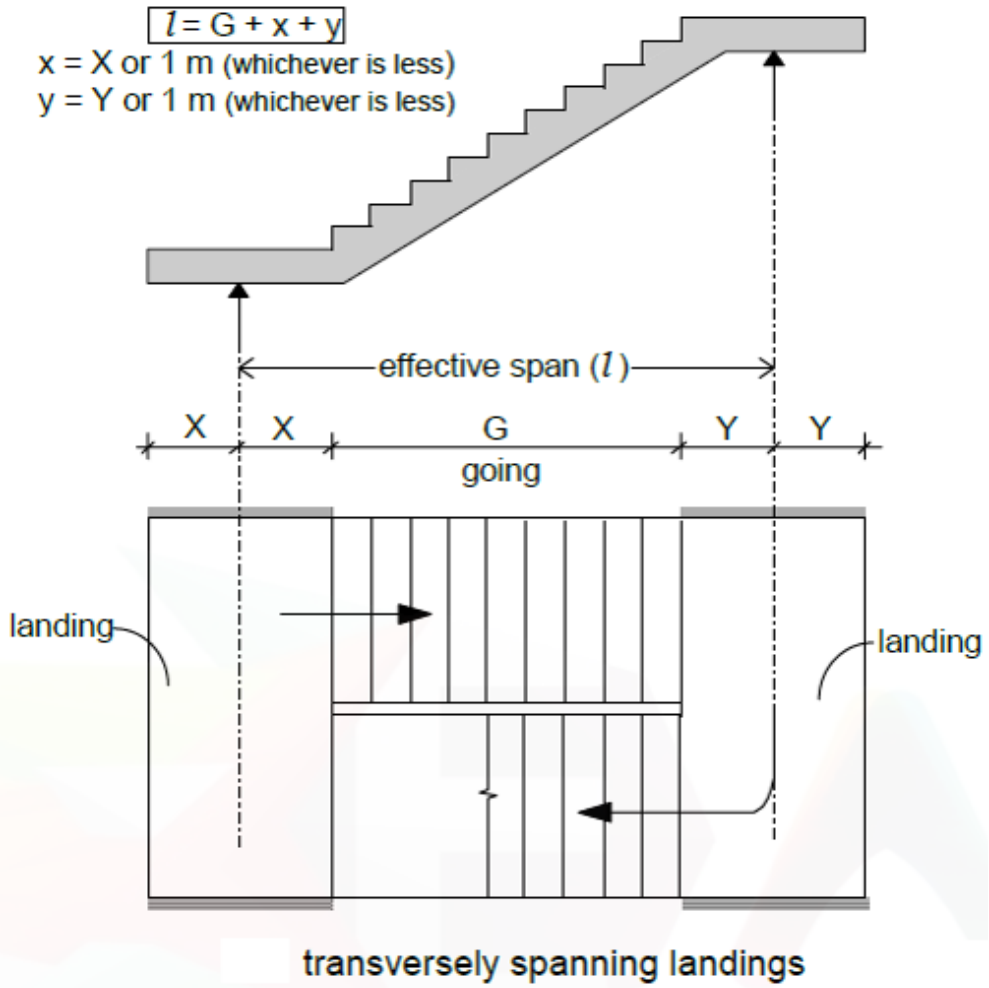
Landing slab spanning in the same direction of staircase

- Effective span of staircase = centre-to-centre distance between the beam/wall supports [Refer Cl.33.1(c) Page 63]



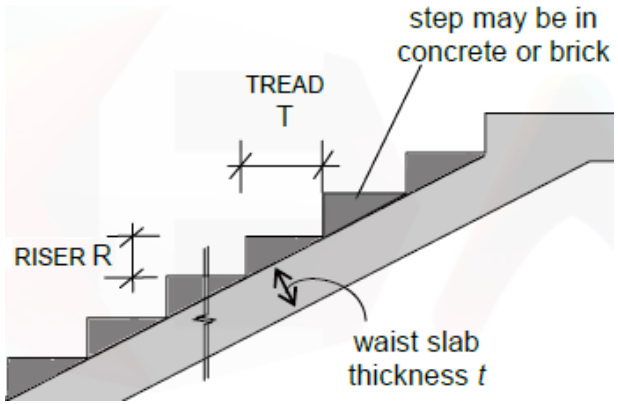
Landing slab spanning transverse to the direction of stairs (or Landing slab span parallel to risers)

- Effective span of staircase
  - Determined based on Fig.17 of IS456 [Refer Cl.33.1(b) Page 63]



Calculation of Loads

- Here loads are calculated separately for Landings and Going.
- The steps are usually treated as triangular non-structural elements and it is the waist slab which is designed to resist the load effects on the stairs.
- Waist slab thickness is determined from limiting values of (l/d) ratios, as in case of one-way slabs. It may be taken equal on both Going and Landing.



Calculation of Loads

Self-weight of waist slab on Going (in kN/m)

= Unit weight of concrete x Width of slab strip x Depth of slab x $\frac{Inclined\ \ Length}{Tread}$

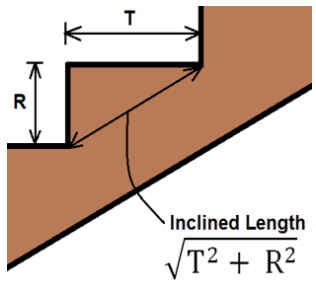
Self-weight of waist slab on Landing (in kN/m)

= Unit weight of concrete x Width of slab strip x Depth of slab

Self weight of steps (in kN/m)

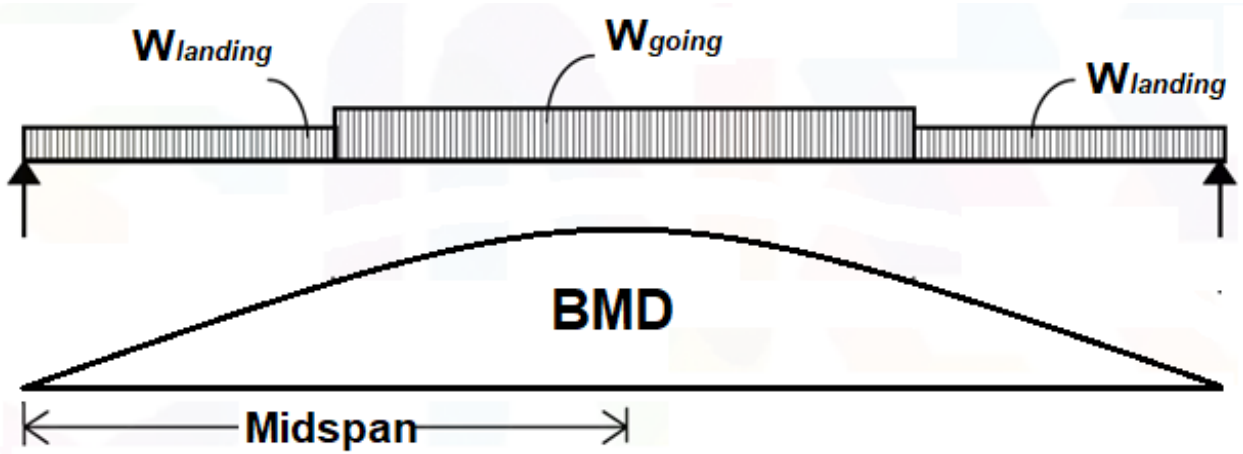
= Unit weight of concrete x Width of slab strip x Average thickness of step

- Unit weight of concrete = 25kN/m3
- Width of slab strip = 1m
- Avg. thickness of step = $\frac{Rise}{2}$



Calculation of Loads

- Maximum Bending moment occurs at midspan of this simply supported slab strip. This is computed.



- These moments may be conveniently computed by considering the entire vertical load w acting on the projected horizontal span (going), rather than along the inclined span.
- The distributor bars are provided in the transverse directions.
- Remaining steps of design is similar to that of one-way slab.

Now solve numerical examples!!!